
Provisioning guidelines

The values and limits used in this document are not necessarily typical and should not be interpreted as limits of the system capacity. The values should be adjusted to suit the application of a particular system. Consult your Northern Telecom representative and use a configuration tool, such as Autoquote or Meridian Configurator, to fully engineer a system.

To determine general equipment requirements, follow the provisioning guidelines in the order shown below. (These provisioning methods are based on a nonpartitioned system.) Use the worksheets prepared in the previous chapter and the reference tables at the end of this document.

- Step 1 Define and forecast growth
- Step 2 Estimate CCS per terminal
- Step 3 Calculate number of trunks required
- Step 4 Calculate line, trunk, and console load
- Step 5 Calculate DTR requirements
- Step 6 Calculate total system load
- Step 7 Calculate number of superloops required
- Step 8 Calculate number of network groups required
- Step 9 Calculate number of peripheral equipment cards required
- Step 10 Calculate number of peripheral equipment modules required
- Step 11 Provision conference/TDS loops
- Step 12 Calculate memory requirements
- Step 13 Assign equipment and prepare equipment summary

Step 1: Define and forecast growth

The first step in provisioning a new system is to forecast the number of telephones required at two-year and five-year intervals.

The number of telephones required when the system is placed in service (cutover) is determined by the customer. If the customer is unable to provide a two-year and five-year growth forecast, then an estimate of annual personnel growth in percent is used to estimate the number of telephones required at the two-year and five-year intervals.

Example

A customer has 500 employees and needs 275 telephones to meet the system cutover. The customer projects an annual increase of 5 percent of employees based on future business expansion. The employee growth forecast is:

- $500 \text{ employees} \times 0.05 \text{ (percent growth)} = 25 \text{ additional employees at 1 year}$
- $525 \text{ employees} \times 0.05 = 27 \text{ additional employees at 2 years}$
- $552 \text{ employees} \times 0.05 = 28 \text{ additional employees at 3 years}$
- $580 \text{ employees} \times 0.05 = 29 \text{ additional employees at 4 years}$
- $609 \text{ employees} \times 0.05 = 31 \text{ additional employees at 5 years}$
- $640 \text{ employees} \times 0.05 = 32 \text{ additional employees at 6 years}$

The ratio of telephones to employees is $275/500$, which equals 0.55. To determine the number of telephones required from cutover through a five-year interval, the number of employees required at cutover, one, two, three, four, and five years is multiplied by the ratio of telephones to employee (0.55).

- $500 \text{ employees} \times 0.55 = 275 \text{ telephones required at cutover}$
- $525 \text{ employees} \times 0.55 = 289 \text{ telephones required at 1 year}$
- $552 \text{ employees} \times 0.55 = 304 \text{ telephones required at 2 years}$
- $580 \text{ employees} \times 0.55 = 319 \text{ telephones required at 3 years}$
- $609 \text{ employees} \times 0.55 = 335 \text{ telephones required at 4 years}$
- $640 \text{ employees} \times 0.55 = 352 \text{ telephones required at 5 years}$

This customer requires 275 telephones at cutover, 304 telephones at two years, and 352 telephones at five years.

Each DN assigned to a telephone requires a TN. Determine the number of TNs required for each customer and enter this information in Worksheet I. Perform this calculation for cutover, two-year, and five-year intervals.

Step 2: Estimate CCS per terminal

Estimate the station and trunk CCS per terminal (CCS/T) for the installation of a system using any one of the following methods:

- comparative method
- manual calculation
- default method

Comparative method

Select three existing systems that have a historical record of traffic study data. The criteria for choosing comparative systems are:

- similar line size (+25 percent)
- similar business (such as bank, hospital, insurance, manufacturing)
- similar locality (urban or rural)

Once similar systems have been selected, their station, trunk, and intra-CCS/T are averaged. The averages are then applied to calculate trunk requirements for the system being provisioned (see the example in [Table 7](#)).

Table 7
Example of station, trunk, and intra-CCS/T averaging

	Customer A	Customer B	Customer C	Total	Average
Line size	200	250	150	600	200
Line CCS/T	4.35	4.75	3.50	12.60	4.20
Trunk CCS/T	2.60	3.0	2.0	7.60	2.53
Intra CCS/T	1.70	1.75	1.50	4.95	1.65

If only the trunk CCS/T is available, multiply the trunk CCS/T by 0.5 to determine the intra-CCS/T (assuming a normal traffic pattern of 33 percent incoming calls, 33 percent outgoing calls, and 33 percent intra-system calls). The trunk CCS/T and intra-CCS/T are then added to arrive at the line CCS/T (see the example in [Table 8](#)).

Table 8
Example of CCS/T averaging when only trunk CCS/T is known

Trunk type	Number of trunks	Grade of service	Load in CCS	Number of terms	CCS/T
DID	16	P.01	294	234	1.20
CO	14	P.02	267	234	1.14
Tie	7	P.05	118	215	0.54
Paging	2	10 CCS/trunk	20	207	0.09
Out WATS	4	30 CCS/trunk	120	218	0.54
FX	2	30 CCS/trunk	60	218	0.27
Private line	4	20 CCS/trunk	80	4	20.00
			Total: 956		Total: 23.79
Note: The individual CCS/T per trunk group is not added to form the trunk CCS/T. The trunk CCS/T is the total trunk load divided by the total number of lines at cutover.					

From the preceding information, trunk CCS/T can be computed as follows:

$$\text{trunk CCS/T} = \text{total trunk load in CCS} / (\text{number of lines}) = 959 / 234 = 4.1$$

Assuming a 33 percent intra-calling ratio:

$$\text{intra CCS/T} = 4.1 \times 0.5 = 2.1, \text{ and}$$

$$\text{line CCS/T} = 4.1 (\text{trunk CCS/T}) + 2.1 (\text{intra-CCS/T}) = 6.2$$

Manual calculation

Normally, the customer can estimate the number of trunks required at cutover and specify the grade of service to be maintained at two-year and five-year periods (see [Table 9](#)). (If not, use the comparative method.)

The number of trunks can be read from the appropriate trunking table to select the estimated usage on the trunk group. The number of lines that are accessing the group at cutover are divided into the estimated usage. The result is the CCS/T, which can be used to estimate trunk requirements.

Example

- Line CCS/T = 6.2
- Trunk CCS/T = 4.1
- 2 consoles = 30 CCS

Table 9
Example of manual calculation of CCS/T

Cutover	Line CCS = $275 \times 6.2 =$	1705
	Trunk CCS = $275 \times 4.1 =$	1128
	Subtotal =	2833
	Console CCS =	30
	Total system load =	2863
2 years	Line CCS = $304 \times 6.2 =$	1885
	Trunk CCS = $304 \times 4.1 =$	1247
	Subtotal =	3132
	Console CCS =	30
	Total system load =	3162
5 years	Line CCS = $352 \times 6.2 =$	2183
	Trunk CCS = $352 \times 4.1 =$	1444
	Subtotal =	3627
	Console CCS =	30
	Total system load =	3657

This method is used for each trunk group in the system, with the exception of small special services trunk groups (such as tie, WATS, and FX trunks). Normally, the customer will tolerate a lesser grade of service on these trunk groups. [Table 10](#) lists the estimated usage on special services trunks.

Table 10
Estimated load per trunk

Trunk type	CCS
Tie	30
Foreign exchange	30
Out WATS	30
In WATS	30
Paging	10
Dial dictation	10
Individual bus lines	20

Default method

Studies conducted estimate that the average line CCS/T is never greater than 5.5 in 90 percent of all businesses. If attempts to calculate the CCS/T using the comparative method or the manual calculation are not successful, the default of 5.5 line CCS/T can be used.

The network line usage is determined by multiplying the number of lines by 5.5 CCS/T. The total is then multiplied by 2 to incorporate the trunk CCS/T. However, when this method is used, the intra-CCS/T is added twice to the equation, and the result could be over provisioning if the intra-CCS/T is high.

Another difficulty experienced with this method is the inability to forecast individual trunk groups. The trunk and intra CCS/T are forecast as a sum group total. Examples of the default method and the manual calculation method are shown in [Table 11](#) for comparison.

Example

- 275 stations at cutover
- 304 stations at two years
- 352 stations at five years

Cutover	$275 \times 5.5 \text{ (CCS/T)} \times 2 =$	3025 CCS total system load
Two-year	$304 \times 5.5 \text{ (CCS/T)} \times 2 =$	3344 CCS total system load
Five-year	$352 \times 5.5 \text{ (CCS/T)} \times 2 =$	3872 CCS total system load

Table 11
Default method and manual calculations analysis

	Default method	Manual calculations	Difference
Cutover	3025	2863 CCS	162 CCS
Two years	3344	3162 CCS	182 CCS
Five years	3872	3657 CCS	215 CCS

Step 3: Calculate number of trunks required

Enter the values obtained through any of the three previous methods in Worksheet I. Add the calculations to the worksheet. Once the trunk CCS/T is known and a grade of service has been specified by the customer, the number of trunks required per trunk group to meet cutover, two-year, and five-year requirements is determined as shown in the following example.

Example

The customer requires a Poisson 1 percent blocking grade of service (see Reference Table 1). The estimated trunk CCS/T is 1.14 for a DID trunk group. With the cutover, two-year, and five-year number of lines, the total trunk CCS is determined by multiplying the number of lines by the trunk CCS/T:

Cutover	275 (lines) x 1.14 (trunk CCS/T) =	313.5 CCS
Two-year	304 (lines) x 1.14 (trunk CCS/T) =	346.56 CCS
Five-year	352 (lines) x 1.14 (trunk CCS/T) =	401.28 CCS

Use Reference Table 2 to determine the quantity of trunks required to meet the trunk CCS at cutover, two-year, and five-year intervals. In this case:

- 17 DID trunks are required at cutover
- 18 DID trunks are required in two years
- 21 DID trunk are required in five years

Note: For trunk traffic greater than 4427 CCS, allow 29.5 CCS/T.

Step 4: Calculate line, trunk, and console load

Once the quantity of trunks required has been estimated, enter the quantities in Worksheet I for cutover, two-year, and five-year intervals. This calculation must be performed for each trunk group to be equipped. The total trunk CCS/T is the sum of each individual trunk group CCS/T. This value is also entered in Worksheet I.

Line load

Line load is calculated by multiplying the total number of TNs by the line CCS/T. The number of TNs is determined as follows:

- one TN for every DN assigned to one or more single-line telephones
- one TN for every multi-line telephone without data option
- two TNs for every multi-line telephone with data option

Trunk load

Trunk load is calculated by multiplying the total number of single- and multi-line TNs that have access to the trunk route by the CCS/T per trunk route.

Console load

Console load is calculated by multiplying the number of consoles by 30 CCS per console.

Step 5: Calculate Digitone receiver requirements

Once station and trunk requirements have been determined for the complete system, the DTR requirements can be calculated. The DTRs are shared by all customers in the system and must be distributed equally over all the network loops.

Reference Tables 3 through 6 are based on models of traffic environments and can be applied to determine DTR needs in most cases. When the system being provisioned does not fall within the bounds of these models or is equipped with any special features, the detailed calculations must be performed for each feature and the number of DTRs must accommodate the highest result.

Some special features are:

- Authorization Code
- Centralized Attendant Service (CAS)
- Charge Account for Call Detail Recording (CDR)
- Direct Inward System Access (DISA)
- Integrated Messaging System Link

Note: Go to “DTR/Feature calculations” on page 89 for more information on these features.

From the appropriate reference table (Reference Tables 3 through 6), determine the number of DTRs required and the DTR load for cutover, two-year, and five-year intervals. Record this information in Worksheet J.

The following models are based on some common PBX traffic measurements.

Model 1

Reference Table 3 is based on the following factors:

- 33 percent intra-office calls, 33 percent incoming calls, and 33 percent outgoing calls
- 1.5 percent dial tone delay grade of service
- no Digitone DID trunks or incoming Digitone tie trunks

Model 2

Reference Table 4 is based on the following factors:

- the same traffic pattern as Model 1
- Digitone DID trunks or incoming Digitone tie trunks
- Poisson 0.1 percent blockage grade of service

Model 3

Reference Table 5 is based on the following factors:

- 15 percent intra-office calls, 28 percent incoming calls, and 56 percent outgoing calls
- 1.5 percent dial tone delay grade of service
- no Digitone DID trunks or incoming Digitone tie trunks

Model 4

Reference Table 6 is based on the following factors:

- the same traffic pattern as Model 3
- Digitone DID trunks or incoming Digitone tie trunks
- Poisson 0.1 percent blockage grade of service

Detailed calculation: Method 1

This method can be used when there are no incoming Digitone DID trunks and the following is assumed:

- Digitone receiver traffic is inflated by 30 percent to cover unsuccessful dialing attempts.
- Call holding time used in intra-office and outgoing call calculations is 135 seconds if unknown.
- Digitone receiver holding times are 6.2 and 14.1 seconds for intra-office and outgoing calls, respectively.
- Factor $(1 - R)/2$ in (1) outgoing (incoming calls and outgoing calls are equal). R is the intra-office ratio.

Follow the procedure below for detailed calculation Method 1.

1 Calculate Digitone calls:

Intra-office =

$100 \times \text{Digitone station traffic (CCS)} \div \text{call holding time} \times (R \div 2)$

Outgoing =

$100 \times \text{Digitone station traffic (CCS)} \div \text{call holding time} \times [(1-R) \div 2]$

2 Calculate total DTR traffic:

$1.3 \times [(6.2 \times \text{Intra}) + (14.1 \times \text{Outgoing})] \div 100$

3 Calculate average holding time:

$(6.2 \times \text{intra}) + (14.1 \times \text{outgoing}) \div \text{intra calls} + \text{outgoing calls}$

4 See Reference Table 7 or 8 and use the answers from steps 2 and 3 to determine the number of DTRs required.

Detailed calculation: Method 2

This method is used when incoming Digitone trunks are included in the system. This method uses the same assumptions as Method 1, with the DTR holding time assumed to be 2.5 seconds for a DID call. Follow the procedure below for detailed calculation Method 2.

- 1 Calculate intra-office and outgoing Digitone calls as shown in step 1 of Method 1:

DID calls =
DID Digitone trunk traffic (CCS) x 100 ÷ call holding time

- 2 Calculate total DTR traffic:

$$[(1.3 \times 6.2 \times \text{intra}) + (1.3 \times 14.1 \times \text{outgoing calls}) + (2.5 \times \text{DID calls})] \div 100$$

- 3 See Reference Table 9 and use the answer from step 2 to determine the number of DTRs required.

Step 6: Calculate total system load

Total the line, trunk, console, and DTR load for each customer to get the total load figure for each customer for cutover, two-year, and five-year intervals. Enter this figure in Worksheets J and K.

Step 7: Calculate number of network loops required

The system network loop requirement is the total of all individual customer loops and superloops required. The number of network loops and superloops required is calculated for each customer for cutover, two-year, and five-year intervals. Network loops and superloops are provisioned at cutover based on the two-year loop requirement figure.

To determine the number of superloops required, first separate the traffic supported by QPC414 Network Cards: data line cards, RPE, and PRI/DTI. The remaining traffic (including DTR traffic) must be engineered for superloops.

Number of superloop network cards or number of superloops =
traffic to be handled by superloop network ÷ 2975

These figures are based on an 85 percent utilization level. Round the value obtained to the next higher number. For options 21A, 21, and 21E, exclude the traffic carried by the ten IPE cards in the CE/PE Module before computing the number of superloop network cards.

Nonblocking configuration with superloop network

For nonblocking applications (or a non-blocking part of the system), provide one superloop for every 120 TNs. Generally, each line or trunk is one TN, but an integrated voice and data line is two TNs (assuming the data port is configured).

Blocking configuration with superloop network

For applications where blocking is allowed, one superloop can serve up to 512 lines (1024 TNs). The actual number of lines depends on the traffic requirement of the lines.

QPC414 Network Cards

The traffic carried by QPC414 Network Cards includes data, RPE, and PRI/DTI traffic (which includes both data and voice traffic).

Provide separate loops for RPE and PRI/DTI traffic. Based on 85 percent utilization, calculate the number of loops required as follows:

- 1 Number of loops =
 traffic to be carried by QPC414 Network Cards $\div$ 560
- 2 Number of QPC414 Network Cards =
 number of loops $\div$ 2

Note: Round the value obtained to the next higher number.

PRI/DTI cards

The PRI and DTI cards provide the interface between the system switch and T-1/DS-1 digital transmission trunks. Digital trunks are offered in a group of 24 trunks. [Table 12](#) lists the number of PRI/DTI cards required when PRI/DTI traffic is known.

Note: The number of PRI/DTI loops is the same as the number of PRI/DTI cards.

Table 12
Number of cards required when PRI/DTI traffic is known

PRI/DTI traffic (CCS)	Number of PRI/DTI cards
1–507	1
508–1201	2
1202–1935	3
1936–2689	4
2690–3456	5
3457–4231	6
4232–5006	7
5007–5781	8
over 5781	provide 8 plus one PRI/DTI for each 774 CCS in excess of 5781 CCS

Note: In a Network Module, if two network slots are available but not next to each other, the network cards can be moved to create a 2-inch slot for a PRI/DTI card.

For nonblocking applications, the Ring Again feature must be provided since blocking may occur at the far end of the trunk.

Since a PRI/DTI card physically occupies two network slots, multiply the number of PRI/DTI cards by two to obtain the required number of slots.

The PRI/DTI cards can be installed in any module except IPE and PE Modules. After all essential cards are configured, estimate the available slots for PRI/DTI. If not enough slots are available for all PRI/DTIs required, a Network Module can be added to the system to house the PRI/DTI cards required.

Step 8: Calculate number of network groups required

Compute the number of network groups based on the total number of loops required (excluding conference/TDS loops). Record the network groups in Worksheet L. Use [Table 13](#) and the following equation to find the number of network groups required:

Total number of loops =
 (4 x the number of superloop network cards) + (2 x the number of QPC414 Network Cards)

Table 13
 Number of network groups based on total number of loops required

Number of network groups	Number of loops
1	28
2	56
3	84
4	112
5	140
Note: Use Worksheet K. Install a multiple-group system if the total number of loops required exceeds 28.	

Note: Based on the criteria above, installing a multiple-group system initially is more cost-effective than converting to a multiple-group system (from a single-group system) between the two-year and five-year intervals.

For options 81 and 81C, use [Table 14](#) to calculate the number of NT6D65 CNI Cards needed to support the network groups.

Table 14
CNI configurations (options 81 and 81C)

Number of network groups supported	Required number of CNI cards	Optional number of CNI cards
"group 5" (bus extender)	1 (slot 8 port 0)	(required)
1 (group 0)	1	2
2 (group 1)	2	3
3 (group 2)	2	up to 4
4 (group 3)	3	up to 5
5 (group 4)	3	up to 5

Step 9: Calculate number of IPE/PE cards required

In Worksheet M, enter the number of DTRs required (from Worksheet J). Use a separate worksheet for cutover, two-year, and five-year intervals.

Using information from Worksheet I, enter the number of single-line telephone TNs, multi-line telephone TNs, and trunk TNs required at cutover, two-year, and five-year intervals (for all customers) in Worksheet M.

Divide each entry by the number of TN assignments for each card, round up to the next higher figure, and total the number of cards required.

Calculate the number of IPE cards and PE cards separately.

Step 10: Calculate number of IPE/PE modules required

The number of peripheral equipment modules provided at cutover is based on the two-year estimate of peripheral equipment cards required and an 85 percent utilization level.

The maximum capacity of an IPE Module is 256 integrated voice and data or analog lines; however, a typical configuration includes a combination of lines, trunks, and DTRs, which provides up to 160 lines.

Divide the number of peripheral equipment cards required at two years by 8.5, round to the next higher number, and enter this value in Worksheet M.

To compute the number of peripheral equipment modules, divide the total number of line, trunk, and DTR cards required at two years by 13.6 and round to the next higher number. Enter this value in Worksheet M.

Calculate the number of IPE and PE Modules required.

Step 11: Provision conference/TDS loops

Conference/TDS loops are provisioned according to the two-year figure for the number of network loops required. All systems must be equipped with a minimum of two conference and two TDS loops.

See Reference [Tables 11](#) and [12](#) to determine conference/TDS loop requirements. Enter these figures in Worksheet N.

Step 12: Calculate memory requirements

Use Worksheets O through Q to calculate memory requirements. Use the two-year figure for telephones, consoles, and trunks for the calculation. Add 10 percent to the total memory requirements.

Note 1: Real-time memory requirements must be calculated using the data in *Capacity Engineering* (550-3001-149).

Note 2: This step does not apply to options 51C, 61C, 81, and 81C because there is no variable number of memory cards; the memory function is performed by the NT6D66 or NT9D19 Call Processor Card.

Step 13: Assign equipment and prepare equipment summary

Use Worksheet R to record the equipment requirements for the complete system at cutover. Assign the equipment. The equipment summary may have to be updated as a result of assignment procedures. Use the finalized equipment summary to order the equipment for the system.

